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SCIENCE ABSTRACTS

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1917

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1917.

GENERAL PHYSICS.

1333. *Mercury-vapour Pumps.* **C. A. Kraus.** (Am. Chem. Soc., J. 39. pp. 2183–2186, Oct., 1917.)—Describes a mercury-vapour pump which will produce the highest vacua, but which only requires to be supported by a water-jet pump. The apparatus consists essentially of two pumps of the Langmuir type [Abs. 963 (1916)] operating in series. The first, which operates against a back pressure as high as 40 mm., yields a vacuum below 1 mm. pressure. The second operates against back pressures up to 7 or 8 mm. The nozzle of the first pump must be sufficiently small to give a high velocity to the mercury vapour; that of the second pump is considerably larger. In the pumps here dealt with the two nozzles are respectively 3 and 8 mm. in diam. and both project 1 cm. into the condensing chamber, the annular space round the nozzles being 0·5 mm. wide. The apparatus is rapid in action, a volume of 1500 cm.^{3} being exhausted to less than 10^{-4} mm. in about 10 minutes. A. W.

1334. *Calculating Device.* **H. G. Deming.** (Am. Chem. Soc., J. 39. pp. 2137–2144, Oct., 1917.)—Describes a calculating chart, to which the name *nomon* has been given, designed to perform all the ordinary operations of a slide-rule, but giving the result correct to 1 unit in the fourth place. The method of use is dealt with at length, and it is pointed out that the method has special advantages for chemical calculations. A method is also indicated by means of which any expression involving only one or two variables, with a number of constants, may be represented by a special scale along one of the margins of the chart, to be treated thereafter as a simple variable, subject to multiplication and division in the usual way. A. W.

1335. *Influence of Air-resistance on the Trajectories of Light Particles in Rotation.* **Z. Carrière.** (Journ. de Physique, 5. pp. 175–186, May-June, 1917.)—The present paper contains the study of the aerial trajectories of spherical balls, made of pith for the sake of lightness, which are set in rotation and projected by means of a special apparatus which is here described in detail. The balls were from 8 to 10 mm. diam. and 0·02–0·03 gm. in weight. The subject-matter is illustrated by 7 diagrams. The trajectories on scrutiny may be reduced to a parabolic branch in the vicinity of the origin, which is transformed and thence continues as a straight line making a certain angle

with the vertical. This angle is the characteristic of the trajectory. Rotation considerably augments the range, so that for the latter to have a given value, deficiency of initial velocity may be compensated by a suitable rotation. The rôle of the air-resistance is considered at some length, and the sense of the deviation produced thereby is shown to be defined by a rule analogous to that of Ampère, namely :—Imagine oneself set on the axis of rotation so that the ball rotates from left to right ; on looking in the direction of translation the deviation takes place towards the right. H. H. Ho.

1336. *The Effusion Method of determining Gas Density.* **J. D. Edwards.** (Bureau of Standards, Technol. Paper, No. 94. [30 pp.], Washington, 1917.) —The effusion method of determining gas density, which is based upon the fact that the times required for the escape of equal volumes of two gases under the same pressure through the same small orifice are approximately proportional to the square roots of the densities of the gases, was investigated in order to determine the accuracy of the method and its sources of error. In co-operation with a number of men employing this method in the natural-gas industry, a series of experiments were made, using their apparatus under field conditions. It was found that results in error by more than 10 % were not unusual.

The theory of the effusion process was investigated in order to determine the influence of the numerous variables affecting the apparent specific gravity. The relative rates of effusion of air as compared with hydrogen, argon, methane, and carbon dioxide at different pressures and with different orifices were determined. A more detailed treatment of the theory in the light of these results will be given in another paper. The results obtained from the present investigation, together with the observations made on the shape and size of the orifice were used in determining the most favourable conditions of operation for this method. Recommendations are made as to the most suitable type and form of apparatus for use, and specifications are given to guide in the construction of the orifice. Although results of high accuracy cannot be expected from apparatus of the effusion type, yet such apparatus will serve well for approximate results or for work where relative values only are needed, as in control work.

It has been shown that the apparent specific gravity as determined by this method can be varied within rather wide limits by changing the conditions. However, by the observance of certain precautions in the construction and use of the apparatus, it is possible to secure results accurate to about 2 per cent. The greatest precision is obtained where the physical properties of the gas tested show the least difference from those of air. Some further increase in accuracy, and particularly in reliability, can be gained by standardising the apparatus, and obtaining a correction factor for the different orifices used. A. F.

1337. *Further Remarks on the Statistics of Bohr's Model.* **K. F. Herzfeld.** (Phys. Zeits. 18. pp. 389–391, Aug. 15, 1917.)—In a recent communication on the application of the quanta theory to the problem of the intensity of the spectral lines, Sommerfeld has referred to an earlier investigation of the present author. Since Sommerfeld has used a different division of the phase medium, the author now offers a few further remarks and suggestions on the subject. The relative probability for states of equal energy to be independent of temperature is assumed, and the whole space of a given orbit is taken as the weight of the orbit, the phase being regarded as constructed of those

orbits. The following limitations are introduced :—(1) The orbits are closed and inalterable. (2) The properties of an orbit are characterised by two parameters. (3) The properties of the orbit as a whole are considered and not the orientation or position of any point on the orbit. It is a very important but still unsolved problem as to whether the Bohr orbits are the only ones possible [analogous to the first Resonator theory of Planck] or whether all orbits are possible, or whether such phenomena as emission mean transitions to orbits of smaller energy, which transitions can only take place from and to a Bohr orbit. This latter assumption corresponds to Planck's second theory. The sharpness of the spectral lines offers no criterion, inasmuch as, in the case of free emission, only Bohr orbits come into notice. Experience may possibly be obtained, however, by means of violent orbit-changes produced by ionic impact, in which the work of ionisation necessary to transfer the molecule from the initial to the final state may be compared with the energy difference of the Bohr orbits. The case of hydrogen is considered in detail. Here two courses are possible for the ionisation : (i) Ionisation of the hydrogen molecule into a neutral atom H, a positive ion $H^{\cdot}$ and an electron ; (ii) ionisation of the molecule into a positive mol ion $H_2^{\cdot}$ and an electron. The structure of the molions $H_2^{\cdot}$ is taken according to Bohr's presentation, viz., that from the molecule only an electron will be taken and the residual structure remain unchanged. A calculation is then given in the paper for the corresponding orbit. The results obtained make it appear probable that the electrons in Bohr's model move between the Bohr orbits 1 and 2. H. H. Ho.

1338. *Waves due to Submerged Obstacle.* **T. H. Havelock.** (Roy. Soc., Proc. 93. pp. 520–532, Sept. 1, 1917.)—The only case, to the author's knowledge, of wave motion due to a submerged obstacle that has been worked out in any detail is Lamb's solution of the two-dimensional motion due to a circular cylinder of small radius and at a considerable depth ["Hydrodynamics," 4th ed., p. 401]. The author here attacks the simplest three-dimensional case, the motion of a submerged sphere. Lamb's solution was obtained by considerations of energy and of work applied to the train of waves. In the case of the moving sphere the wave system is more complicated, and the author's procedure has been, first, to carry Lamb's approximation a stage further, thereby showing that the resultant horizontal pressure on the cylinder is the same as the wave resistance obtained by the energy method, and then to calculate directly the horizontal resultant of the fluid pressure on the sphere. The successive stages of the approximation to the velocity potential are most simply described in terms of successive images. The first stage ϕ_1 is the image of a uniform stream in the submerged body ; the second, ϕ_2, is the image of ϕ_1 in the free surface ; the third, ϕ_3, is the image of ϕ_2 in the submerged body, etc. To keep the integrals convergent, a small frictional coefficient is introduced in the usual manner, and put equal to zero after the calculation. Moreover, the solution for uniform motion is so built up that, although the final state only has been studied in detail, expressions can be found for the velocity potential at any time after the motion started. The wave-resistance of a sphere is found to be expressible in the form : Constant $\times \alpha^{3/2}e^{-\alpha/2}W_{1,1}(\alpha)$, where $\alpha = 2gf/c^2$, f being the depth of the centre of the sphere, c its velocity, and $W_{1,1}(\alpha)$ a confluent hypergeometric function. A graph is given expressing the wave resistance as a function of the velocity, the curve obtained being very similar in form to the two-dimensional case of a circular cylinder. The author points out that the method adopted can be applied to bodies of different forms. G. W. de T.

1339. *Virtual Displacements of Electromagnetic and Gravitational Fields in Einstein's Theory.* **A. D. Fokker.** (K. Akad. Amsterdam, Proc. 19. pp. 968–984, 1917.)—In applying Hamilton's principle to obtain the principal equations of Einstein's gravitation theory, Lorentz [Abs. 720 (1917)], starting from an invariant equation, reaches, by a convenient artifice, conclusions represented by invariant equations, without keeping to invariant equations throughout the argument, so avoiding the necessity of determining the conditions of invariancy. These conditions are investigated here, and the author shows that the argument may then be formulated so as to conserve the invariancy throughout. Examination of the geometrical meaning of the tensor components g_{ab} leads to the conclusion that they form together an infinitesimal quadratic three-dimensional extension, the "indicatrix" around each point-instant of the field figure; and the whole gravitational field may be said to be represented by the totality of the indicatrices described around the different point-instants, much as an electrical field is described by Faraday lines of force. A virtual displacement of the gravitation field must therefore mean a displacement of all those indicatrices in such manner as not to disturb the configuration and intersections of the indicatrices. The ten differential equations $G_{ab} - \frac{1}{2}g_{ab}G = 0$, which determine the gravitational field for those portions of the extension where there is neither matter nor an electromagnetic field, are shown not to be independent, the gravitational potentials being subject to four arbitrary additional connections, an indefiniteness which, however, as Einstein has shown, can give rise to indefiniteness in no observation possible with material instruments. In conclusion, the author shows briefly how the formulæ deduced are connected with the ordinary formulæ of the electron theory. G. W. DE T.

1340. *Gravitational Instability and Figure of the Earth.* **J. H. Jeans.** (Roy. Soc., Proc. 93. pp. 413–417, Aug. 1, 1917.)—In an earlier paper [Abs. 237 (1904)] the author attempted to examine whether, owing to gravitational instability, an arrangement in concentric spherical shells might not be unstable for a planet the size of our earth. It then seemed possible to attack the problem only by a highly artificial assumption, and on that basis it appeared that the symmetrical configuration would be stable under present conditions, but seemed probable that it might have been unstable in past ages when the earth had less rigidity, and that then the stable configuration would be unsymmetrical, the surfaces of equal density being spherical but not concentric, so that the point of max. density coincided neither with the centre of gravity nor with the figure centre of the earth's surface. It was suggested that traces of this unsymmetrical configuration might still be found in the arrangement of oceans and plateaus on the earth's surface. Rayleigh suggested [Abs. 1191 (1906)] the substitution of the more natural assumptions that we might regard the symmetrical configuration as one in which the gravitational forces were balanced by hydrostatic pressures only, and the additional stress due to disturbance as being connected with the additional strain by the ordinary elastic-solid relation. This definite mathematical problem was attempted by Love in 1911 in his Adams Prize Essay, "Some Problems of Geodynamics," under the limitations that the initial density and the elastic constants were constant throughout instead of being functions of r. He then showed that if the rigidity were rather small, compared with the resistance to compression, the body might be unstable in respect of displacements specified by spherical harmonics of the first degree, although stable as regards radial displacement—a result, he remarks, "distinctly favourable to the hypothesis that the division of the earth's surface into a land-hemisphere and a water-hemi-

sphere might be a survival from a past state in which a symmetrical arrangement would have been unstable." Simple considerations dealt with, however, in the present note seem to show that, apart from highly artificial mathematical possibilities, which could hardly be considered possible in a natural system, when the density and elastic constants are allowed to take their natural course as determined by the configuration of the mass, this result is no longer true. The spherical symmetrical arrangement appears always to be stable, so that the attempted explanation of the earth's dissymmetry of figure fails entirely. G. W. DE T.

1341. *Preliminary Results of the Study of Deep-sea Currents by Means of the Bathy-rheometer.* **Y. Delage.** (Comptes Rendus, 165. pp. 277–283, Aug. 20, 1917.)—The author recently (1912) described an instrument, which he called a bathy-rheometer, for the continuous registration of the direction and speed of deep-sea currents. He now describes two modifications of his instrument which are found to be essential for its practical utility. The first is a device for the release and withdrawal of the portion which is submerged, so that the minimum of danger may be obtained especially in a rolling sea. The second modification has been necessitated by a graver difficulty, and the solution proposed for the present is not yet perfected. This difficulty arises from the fact that the apparatus, in addition to the pressure exercised by the current which it registers, is subjected to vortex movements which cause an erratic registration when the current is strong. On the graphs these abnormalities appear as parasitic curves which are hard to distinguish. A full description is given of the mechanism devised for reducing these vortex motions to a minimum. For making a complete study of the working of the bathy-rheometer, the author has conducted a series of observations at a fixed station, the average depth of the sea being about 30 m. and the currents extremely brisk. Two graphs relating to orientation and intensity are included and are accompanied by a detailed description of their significance. H. H. Ho.

1342. *Observations upon the Alkalinity of the Surface Water of the Tropical Pacific.* **A. G. Mayer.** (Nat. Acad. Sci., Proc. 3. pp. 548–552, Sept. 15, 1917.)—On a voyage from San Francisco to Honolulu and thence to Pago Pago, Samoa, daily observations were made of the hydrogen-ion concentration of the surface water, using for this purpose a set of standardised thymol-sulphonephthalein tubes. It was found that in the mid-Pacific, NNE. of Samoa, the surface water at or near the equator was cooler, and less alkaline than 5°–10° north or south of this region. It seems that the water of the equator at 24·9° C. is so low in alkalinity as to be comparable in this respect with the water of only 15° C. about 300 miles off the mouth of San Francisco Harbour. This low alkalinity of the equatorial water was usually, although not invariably, associated with a decided easterly set opposite in direction to the prevailing westerly surface drift of the tropical Pacific. This suggests that counter-currents at the surface in the tropical Pacific may be regions wherein the cold bottom water is rising to the surface; and that this cold water has not yet had time to come into equilibrium with the CO_2 of the atmosphere, and thus still retains some of the relative acidity associated with its former low temperature. Similarly, cold currents may drift into warmer regions and retain their relative acidity to a greater degree than is warranted by their augmenting temperature. Several tables are given in the paper but no definite relation between the salinity and the hydrogen-ion concentration of the ocean water could be established. No conclusions could be drawn from the observations, but if further studies demonstrate low alkalinity to be

usually associated with an easterly set of surface currents over the tropical oceans, the fact may become of importance to navigation owing to the ease and rapidity with which colorimetric tests of the alkalinity of sea-water may be made by means of a graded series of thymolsulphonephthalein tubes.

H. H. Ho.

1343. *Astronomical Consequences of Electrical Theory of Matter.* **O. J. Lodge.** (Phil. Mag. 34. pp. 81–94, Aug., 1917.)—Einstein, on the basis of the relativity theory, has offered an explanation of the well-known discordance in the motion of the perihelion of Mercury, and has predicted the gravitative deflection of a ray of light. Lodge suggests the possibility of a simpler explanation in the former case, on the basis that motion of matter through ether has a definite meaning, and that an extra inertia is to be expected at high speeds, in accordance with the Fitzgerald-Lorentz contraction, assuming further, that this extra inertia is not affected by gravity. His treatment is founded on the familiar equation of particle dynamics $d^2u/d\theta^2 + u = F/mh^2u^2$, and leads to the conclusion that, for a planet moving in a circular orbit, so that the gravitation would, according to his assumptions, remain constant, the variation of inertia due to the cyclical variation in the angle between the direction of orbital motion, and that of the unknown motion of the whole solar system through the ether, would give rise to a progression of the apses, and hence to variations in the motion of the perihelion. In the actual case of elliptic orbits, there would also be a change in the eccentricity. Then, provided existing astronomical data will suffice to effect a determination, we should be able to ascertain whether or not a possible value could be found for the solar motion in space which would account for this discordance without giving rise to others. With respect to the gravitative deflection of a ray of light, the author observes that a wave-front undoubtedly simulates some of the properties of matter. Poynting has shown that it conveys momentum, and an advance wave-front presumably has to sustain and convey the light-pressure until a target is struck. The mechanical stress exists ultimately between source and receiver; but though one end acts on the source, all the time, the other has to react on the advancing wave-front until the receiver is reached, unless Newton's third law meets with some exception. Does such a momentum inertia constitute a sort of temporary matter, and if so, is it subject to gravity? Should the latter be the case, the problem of determining the gravitative deflection of a ray would become the simple one of reckoning the angle near the sun between the asymptotes of a small comet moving with immense velocity in a hyperbolic orbit. The question is one for experiment.

A. S. Eddington. (*Ibid.* 34. pp. 163–167, Sept., and pp. 321–327, Oct., 1917.)—With respect to Lodge's proposed explanation of the discordance in the motion of the perihelion of Mercury, Eddington shows that existing astronomical data claim to be quite sufficiently definite to follow up the theory he suggests. He finds, however, on the basis of the equation employed by Lodge, that a solar motion of the amount necessary to produce the motion of the perihelion of Mercury, would make the elements of the earth discordant if it were in the ecliptic plane, and would make the eccentricity of Mercury discordant if it were normal to the ecliptic. And since the effects of component velocities are additive, it is easily seen that an intermediate direction would have no better success. As a result of correspondence between Lodge and Eddington, it was noted the fundamental equation employed by the former required modification, owing to the introduction of

variable inertia. Accordingly the problem receives more exact treatment in the second paper, and the author's conclusion is that, so far as he can see, his previous conclusions are not materially modified thereby. G. W. DE T.

1344. *Permanent Periodicity in Sun-spots.* **J. Larmor** and **N. Yamaga.** (Roy. Soc., Proc. 93. pp. 493–506, Sept. 1, 1917.)—A re-examination of the available sun-spot records for the 160 years from 1750 to 1910, leads to the conclusion that an unbroken solar periodicity of about 11·125 years is firmly established, if the two strongly discrepant cycles from 1776 to 1798 are left out of consideration. The graph of this periodic constituent is shown to have the property of being anti-symmetrical with respect to the axis which bisects its undulations, each undulation giving equal areas above and below, the curve repeating as a reflected image. Examination of the residuals after extraction of the 11·125-year pulses shows no indication of periods other than are sporadic in character. A letter is appended from Wolfer, of Zurich, giving interesting particulars concerning the compilation of the sun-spot data, those of the discrepant period from 1775 to 1795 being almost exclusively made by Stoudacher of Nuremberg. The epochs of maxima 1778 and 1787 are considered fairly reliable, and the large departures of the lengths of the periods observed between 1770 and 1805 from the mean value of 11·125 years are to be considered as real. C. P. B.

1345. *Theory of Hyperion.* **J. Woltjer, Jr.** (K. Akad. Amsterdam, Proc. 19. pp. 1225–1232, 1917.)—A theory is developed for the motion of Saturn's satellite Hyperion, to include perturbations by the larger satellite Titan. It is expected that it will be possible to develop the solution in terms of powers of the eccentricity of Titan, contrary to the views expressed by Newcomb. C. P. B.

1346. *Solar Prominence of* 1916 *May* 26. **J. Evershed.** (Kodaikanal Obs. Bull. No. 55. Nature, 100. pp. 52–53, Sept. 20, 1917. Abstract.)—A detailed account is given of the large eruptive prominence of 1916 May 26, which reached a height of 500,000 miles, and in some parts attained a velocity of 457 km. per sec. All parts of the prominence were moving radially outwards from a point in the chromosphere at the base of the main column [Abs. 107 and 1102 (1917).] C. P. B.

1347. *Total Lunar Eclipse,* 1917 *July* 4. **L. Picard.** (Comptes Rendus, 165. p. 264, Aug. 13, 1917.)—Observations by three persons during the lunar eclipse of 1917 July 4, at the Bordeaux-Floriac Observatory, indicated that the edges of the moon's limb appeared much brighter than the central portions. Also that the northern limb appeared brighter than the southern, the moon passing to the north of the axis of the shadow cone; and that the Western limb was most luminous until the middle of the eclipse, and the Eastern limb during the second half of the eclipse. These facts indicate that the phenomenon is due to the solar rays being refracted on passage through the terrestrial atmosphere. C. P. B.

1348. *Empirical Law of Planetary Distances.* **G. Armellini.** (Observatory, No. 517. pp. 346–348, Sept., 1917.)—In the case of the eight principal planets their distances may be represented by the formula $x_n = a + bc^n$, where a, b, and c are given appropriate values. The well-known law of Bode represents all the planetary distances except that of Neptune with fair accuracy, and by a rearrangement of the assumed values L. Gaussin in 1880 obtained a better value for the distance of Neptune, but at the expense of

introducing worse values for Uranus, Jupiter, and Mars. Later, E. Belot in 1905, obtained a new series on the assumption of four infra-Mercurial planets. Armellini proposes that if, instead of assuming vacant places between the Sun and Mercury or between Mercury and Venus, we admit the existence of a single vacant place between Saturn and Uranus, a much simplified formula becomes available, namely, $x_n = 1{\cdot}53^n$. The value 1·53 is the ratio between the mean distances of Mars and the earth from the sun. C. P. B.

1349. *Southern Tail of Halley's Comet in May*, 1910. **E. E. Barnard.** (Astrophys. J. 46. pp. 83–84, July, 1917.)—Some question having arisen as to the effect of the zodiacal light on the fainter southern tail of Halley's Comet seen on May 17 and 18, 1910, special observations of the zodiacal light have been made at Yerkes this year (1917) during the latter part of May, and it is concluded that so far as the observations made at that station are concerned, the appearance was due to a second tail of the comet, and in no way due to the zodiacal light. C. P. B.

1350. *Colour Indices of Stars in Galactic Clouds.* **H. Shapley.** (Mt. Wilson Solar Observat. Contrib. No. 133. Astrophys. J. 46. pp. 64–75, July, 1917.)—An investigation has been made of the colours and magnitudes of 300 stars in the immediate neighbourhood of the cluster M11, which is surrounded by one of the richest of the galactic clouds. A wide range of colour is present, but the change of colour with brightness is hardly perceptible. The magnitudes of the blue stars indicate the remoteness and great dimensions of the star-clouds, and the results point to a diameter of the galactic system greater than is generally supposed. The cluster M11 is shown to be a physical group in the midst of the star-clouds, which on their part have the general appearance and some of the properties of an enormous but definitely outlined physical system. There appears to be no evidence of dwarf stars, either in M11 or in the galactic clouds. [See Abs. 114, 736, 744, 745, and 898 (1917).] C. P. B.

1351. *Photographs of Nebulæ with 60-inch Reflector.* **F. G. Pease.** (Mt. Wilson Solar Observat., Contrib. No. 132. Astrophys. J. 46. pp. 24–55, July, 1917.)—The great light-gathering power of the 60-in. reflector at Mt. Wilson renders it well adapted for the photographic study of faint nebulæ, and details are given of a number thus investigated, the selected objects being in general those whose real nature was unknown, or which possessed curious or questionable characteristics. The photographs are classified according to structural type—elliptical, spiral, planetary, irregular, or spindle-shaped—and a brief description is given of the principal features. The type of spectrum is added where available. Many illustrations are included from the more striking of the photographs. C. P. B.

1352. *Light-curves and Orbital Elements of TT Lyræ and Y Camelopardalis.* **M. B. Shapley.** (Astrophys. J. 46. pp. 56–63, July, 1917.)—The orbital elements are computed for two eclipsing binaries from photographic light-curves obtained by Miss Harwood at Harvard Observatory. The theoretical curves represent the observations well within their probable errors, and shallow secondary minima have been observed for both variables. In the system of TT Lyræ the stars are slightly ellipsoidal, and the reflection effect is peculiarly large. The two systems are remarkably similar in many respects, and have periods of 5·2437 days and 3·3056 days respectively. Both are estimated to be more than 3000 light-years distant from the earth. C. P. B.

LIGHT.

1353. *Selective Reflection and Absorption in Ultra-violet.* **E. O. Hulburt.** (Astrophys. J. 46. pp. 1–23, July, 1917.)—Investigations of the selective reflection from liquid surfaces have been made by Nutting, Martens, and Flatow [Abs. 285, 302 (1902)], dealing chiefly with the positions of maxima and regions of absorption. The present work summarises the results of quantitative measurements of the reflecting powers of seven liquids (carbon disulphide, α-monobromnaphthalene, cinnamic aldehyde, cassia oil, barium mercury iodide in aqueous solution, phenol, and bromine). The observations were made with a grating spectrograph and sodium photoelectric cell. The first four liquids exhibit traces of selective reflection ; the last three do not. The reflective power of mercury in contact with quartz has also been determined, and was used as comparison for each of the other liquids. C. P. B.

1354. *The Life of Reinforcing Screens.* **G. Hartung.** (Archives d'Él. Médicale, 25. p. 424, Sept., 1917.)—Specimens of screens are cut into equal parts. One part is placed in a special box at a distance of 17 cm. from the antikathode and acted upon by the radiation, the other is kept as control. After a total exposure of about 56,000 secs. the specimens are arranged upon a photographic plate and radiographed. In order to compare the effects so obtained with those obtained in practice, it is necessary to take into consideration that the usual distance of the screen from the antikathode is 50, not 17 cm. This means that it would require under normal conditions 484,429 secs. to produce a corresponding effect. If five radiographs with screen are taken per day and the exposure in each case is 2 secs., then it would take about 134 years to produce the same modification in the screen as that produced in these experiments in 56,000 secs. A. E. G.

1355. *Photo-inversion by Light.* **H. Saegusa.** (Math. Phys. Soc., Tōkyō, Proc. 9. pp. 178–185, Sept., 1917.)—The reversal of photographic pictures by visible rays has been one of the most interesting problems in the history of photography, and has attracted the attention of many investigators—there is, however, much left for dispute on account of incomplete experiments. J. Herschel and W. Abney state that the less refrangible rays counteract the more refrangible ones for solarisation. On the other hand, Waterhouse and J. M. Eder conclude that with ordinary photographic plates such an action does not exist. Lüppo-Cramer states that the results of W. Abney's investigation depend upon the duration of exposure, and that if we omit the time of exposure, we have a good instance of the "antagonistic effect of the less refrangible rays" and hence there is no abnormal solarisation.

The present investigation was undertaken in order to study the antagonistic effect of the less refrangible rays above referred to, and also the nature of the photographic reversal by the action of light transmitted through various colour-filters. It is found that the reversing effect of photographic pictures is very intense by violet and blue rays, and becomes gradually less as the refrangibility of the rays decreases. The effect of photographic reversal increases with the intensity of light of the second exposure, and reaches a maximum at a certain intensity, after which it remains constant ; but the photographic film becomes wholly dark for the stronger intensity. The effect of reversal increases with the duration of the second exposure, but after reaching a max. value it does

not increase any further. The photographic film becomes wholly dark for the longer duration of exposure. The photographic negative (not fixed) obtained by weaker light and by shorter duration of the first exposure, becomes positive more easily by weaker light and shorter duration of the second exposure than that obtained by the stronger light and by the longer exposure. There is no decrease of the effect of reversal by superposing green and red rays upon violet and blue ones, even though the intensity of these rays is stronger than that of violet and red rays. So far as the present investigation is concerned, the less refrangible rays do not counteract the more refrangible ones for the reversal of photographic pictures, as Lüppo-Cramer believed.

A. E. G.

1356. *Mathematical Structure of Band Series.* **R. T. Birge.** (Astrophys. J. 46. pp. 85–103, Sept., 1917.)—This paper is concerned exclusively with the relationship between the individual lines of a single band series, *i.e.*, with that relationship for which the first Deslandres' law is a first approximation. No satisfactory formula for long band series has up to now been proposed. In the case of the main (A_1) series of the 3883 CN band—a series of 164 known lines—it has been found by the author that the relation between first frequency-difference ($\Delta\nu$) and a variable m is that of a hyperbola. The hyperbola cuts the origin, but its axes are not parallel to the coordinate axes, so that it is given by a four-constant equation. The actual frequencies are then given by the five-constant formula $\nu_0 + \Sigma\Delta\nu$, and the agreement between observed and computed values is of such accuracy as to indicate that the hyperbola represents a true relation, and one which, it is hoped, will readily lend itself to a possible theory of molecular structure. The $\Sigma\Delta\nu$ cannot conveniently be replaced by the $\int\Delta\nu$, and the formula has some troublesome features, but these are shown, in the light of the experimental facts, to be not unexpected. According to this new formula, a band series should end in a tail having the same structure as the head of any band series, in contrast with Thiele's tail, the structure of which should be that of the head of a line series. No series has been followed to its tail, and in the case of three series of the 3883 band there are no observable tails at the predicted positions, although in one case the series can be followed to within 12 Å.U. of the hypothetical tail. The intensity relationships, however, do not indicate that the tail should actually appear. But few band series show sufficient deviations from the simple Deslandres' law to constitute a rigid test for the proposed hyperbolic formula, while in only one known band are the deviations of a nature contrary to that predicted by this formula. The numerical results for the A_1 series only are presented in the present paper. Those for the B_1 and C_1 series will be published later. [See Abs. 1162 (1911).] A. W.

1357. *Critical Study of Spectral Series.* IV. **W. M. Hicks.** (Roy. Soc., Phil. Trans. 217. pp. 361–410, Oct. 23, 1917.)—Comparatively little is known as to the structure of spark spectra, beyond the fact that in some of them sets of lines with the same frequency-difference are met with. The present paper is an attempt to throw some light on this question, and deals with the spectra of silver and gold. It is shown that the structure of the spectra depends on long series of constant frequency-differences, and the results are represented graphically in 16 maps, in which related lines are connected by links. It is found that, starting from any link belonging to the ordinarily recognised series, a series of other lines can be linked up to them in succession. In the maps the wave-numbers increase from left to right, and they are arranged in vertical

columns. Adopting the same notation as in previous papers [Abs. 1953 (1913)], the small p links stretch from one column to the next, the s links from one to the second from it, and the long e link over three. From these maps lists are formed of some of the lines expressed as sums of multiples of the $p(x\Delta)$, $s(x\Delta)$ by considering them in succession with their links, which exhibit a remarkable number of parallel and series groupings. Further work on these lines will be given later. [See Abs. 217 (1917).] A. W.

1358. *Stark-effect for Metals.* **J. A. Anderson.** (Mt. Wilson Solar Observat., Contrib. No. 134. Astrophys. J. 46. pp. 104–116, Sept., 1917.)—The object of the work here described was to find a method suitable for the study of the Stark-effect for metals having a relatively high melting-point. The spectra of such metals as Fe, Ni, Cr, V, and Ti are of special importance in solar work, and if some of their lines show an effect due to an electric field it would at once become possible to determine whether electric fields exist in the solar atmosphere. The apparatus used was a bell-jar about 15 cm. in diam. and about 30 cm. high, sealed on to a glass plate in which there are two openings, one of which is connected to the pump. The central opening is fitted with a glass tube, into which is ground a long silica tube (D) whose upper end fits inside a short silica tube (C) which has a vertical slot. The kathode is in two parts, the lower of iron and the upper of the metal to be studied, and it rests inside the tube C on the end of the tube D. The anode is a massive Al disc on the end of an Al rod fitted through the knob of the bell-jar. Direct current to produce the discharge was supplied by a set of high-potential generators in series, each giving about 800 volts. For most of the work 8 generators were used. A plane grating, two-lens type of spectrograph was employed, details of which are given. With this apparatus it was found that the relation between field-intensity and distance from the negative glow was approximately linear. The condition of the kathode appears to be of great importance, a sensitive condition arising after about six runs, and persisting until it became necessary to clean the apparatus. A preliminary survey of the spectrum of chromium from λ3670 to λ5410 has been completed, and a total of 74 affected lines recorded. Further results will be given later. A. W.

1359. *X-ray Analysis and Topic Axes of Alkali Sulphates, and their Bearing on the Theory of Valency Volumes.* **A. E. H. Tutton.** (Roy. Soc., Proc. 93. pp. 72–89, Feb. 1, 1917. Abstract.)—One of the most interesting facts brought to light in the course of the author's crystallographic investigations of the rhombic sulphates and selenates of potassium, rubidium, cæsium, and ammonium and of their monoclinic double salts, is the approximation in structure which has invariably been observed between the rubidium salt of any group and the ammonium salt of the same group (see Roy. Soc., Phil. Trans. 217. pp. 199–235, 1917). While differences occur between the structural dimensions of the potassium, rubidium, and cæsium salts (differences following the order of atomic weights), the ammonium salt has without exception proved to possess structural dimensions (*i.e.* directional dimensions and volume of unit cell of lattice) almost identical with those of the rubidium salt, the central member of the group.

It has been shown that the molecular volume and topic axial ratios of the ammonium salt are strictly comparable with those of the alkali metallic salts, and is truly amorphous with these salts. Comparing molecular volumes of the four salts it is also shown that the values for the ammonium salt are

almost identical with those of the rubidium salt. Thus the author concludes that the structures of these salts are not only similar but practically congruent—the space-lattices being practically identical. This conclusion implies that two atoms of rubidium are replaced by the 10 atoms of $2NH_4$ *without any opening up of the structure.*

This result, emphasised by the author, is a direct contradiction of the "Valency Volume" theory of Pope and Barlow [see Abs. 904 (1907)], the essence of which theory is that each valency in a given compound has the same volume, and that therefore the atomic volumes of combined elements are directly proportional to their valencies.

X-ray spectroscopic measurements carried out, at the suggestion of the author, by A. Ogg and F. L. Hopwood [Abs. 79 (1917)] give further support to the views expressed above. These X-ray measurements, based on the accurate knowledge of the wave-length of the X-rays employed, of the absolute lengths of the edges of the rectangular ortho-rhombic cells of the space-lattices, agree perfectly with the topic axial ratios for these salts determined crystallographically by the author. The absolute volumes of the unit cells of the space-lattices of ammonium and rubidium sulphates are within 1 per cent. of identity, just as are the molecular volumes; and the absolute lengths of the three edges of the elementary cells for the two salts are correspondingly close to each other, and in a manner precisely like that shown by the topic axial ratios.

As the volume of the unit cell of ammonium sulphate should be at least twice that of rubidium sulphate according to the Valency Volume Theory of Barlow and Pope (*i.e.* if valency of N is 2, since the sums of the valencies of $(NH_4)_2SO_4$ and Rb_2SO_4 are 24 and 12 respectively), whereas the volumes of the unit cells of the two salts are proved by direct X-ray measurement to be nearly identical, it is proved that the Valency Volume Theory is not universal in its application. A. B. W.

1360. *Crystal Structure of Garnet.* **S. Nishikawa.** (Math. Phys. Soc., Tōkyo, Proc. 9. pp. 194–197, Sept., 1917.)—An X-ray spectroscopic investigation of the structure of $Fe_3Al_2(SiO_4)_2$—a garnet belonging to the regular system of the holohedral class. Using the well-known Bragg reflection method, and in addition the Laue "transmission" method, the author has determined the form of space-lattice which seems to satisfy most of the conditions pertaining to such a complex crystal as garnet. A. B. W.

1361. *Structure of Nitrates of Lead, Barium, and Strontium.* **S. Nishikawa** and **K. Hudinuki.** (Math. Phys. Soc., Tōkyō, Proc. 9. p. 197, Sept., 1917.)—These nitrates crystallise in a hemihedral form of the regular system. The method of investigation was that of the preceding Abs., *i.e.* by analysis of the diffracted spots in Laue photograms, and by reflection from the principal faces of the crystal. The investigation is as yet incomplete, but preliminary and tentative results are given. A. B. W.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1362. *Magnetic Inertia.* **G. W. Walker.** (Roy. Soc., Proc. 93. pp. 442–447, Aug. 1, 1917.)—A magnetised body must possess magnetic inertia, just as an electrified body possesses electric inertia. The method of dimensions shows that the magnetic inertia of a body of magnetic moment m should be a numerical multiple of $m^2a^{-3}c^{-2}$, where a is a linear dimension, *e.g.* the radius of a sphere, and c is the speed of radiation. The problem may be investigated and the numerical factor determined by the same general method as that employed by the author [Abs. 708 (1910)] in determining electric inertia and which is used here, or more simply, as J. J. Thomson has suggested to the author, by the method originally employed by the former to calculate the electric inertia of a charged sphere. The author suggests several applications of the results obtained, *e.g.* the earth's electric inertia, assuming a normal potential gradient at the surface of 1 volt/cm., amounts to 2·1 gm., while the magnetic inertia, parallel to its magnetic axis is $1{\cdot}3 \times 10^4$ gm., assuming Gauss's value of $8{\cdot}6 \times 10^{25}$ C.G.S. magnetic units. The magnetic inertia is therefore considerably greater than the electric, although very small compared with the gravitational inertia of 6×10^{27} gm. The value of the magnetic inertia is also of interest in the theory of electrons and magnetons.

G. W. DE T.

1363. *Effective Electrical Inertia at High Speeds.* **G. W. Walker.** Roy. Soc., Proc. 93. pp. 448–455, Aug. 1, 1917.)—The author, in an earlier paper [Abs. 708 (1910)], developed a method of deducing the electrical inertia directly from the electromagnetic equations, as the deduction, in the case of a system moving at a high constant speed, from the energy or electromagnetic momentum of such steady state was shown to be logically incorrect. It is here applied to the electron under the Fitzgerald-Lorentz contraction.

It is found that the results obtained by Lorentz and by the relativity method are not confirmed, so that, unless some arithmetical error has occurred, the difference found is vital in the application to the experiments on β-rays. An examination of the experiments so far published on the inertia of electrons leads the author to the conclusion that it is very difficult to maintain that the Lorentz-Einstein formula is correct, and hence that the inertia is wholly electromagnetic, and that the electron is contracted in the ratio $1(1 - v^2/c^2)^{1/3}$. Experimentally it is found that J. J. Thomson's formula, or the corrected formula for a contracted electron, agrees equally well with observation, but assigns a proportion of ordinary inertia. The experiments are, in fact, inadequate to distinguish between a number of formulæ that might be proposed. Theoretically the author has shown that J. J. Thomson's formula is confirmed by his analysis, and that the Lorentz-Einstein formula requires modification in the manner stated. He considers that either the relativity correspondence must be abandoned, or electrons as altered experimentally must be regarded as possessing ordinary as well as electromagnetic inertia. G. W. DE T.

1364. *Kinetic Potential in Electromagnetics.* **R. Hargreaves.** (Cambridge Phil. Soc., Trans. 22. No. 11. pp. 191–214, July, 1917.)—The volume integral, over an infinite electromagnetic field, expressing the difference between the electric and magnetic energies according to Maxwell's equa-

tions as modified by Fitzgerald and Lorentz has been called the Kinetic Potential. The term suggests an advance from the infinite electromagnetic field representation to a dynamical one in terms of a single function of the coordinates of charges, and their derivatives with respect to time, and a normal K.P. is in fact a complete statement of a dynamical problem.

It is shown that the electromagnetic K.P. is not normal, as was to be anticipated from the necessity of accounting for dissipation of energy and momentum. Now dissipation is a flux at infinity, which is a feature of the other two important volume integrals of electromagnetic theory, which deal with the fluxes of energy and momentum respectively, and the author has shown that when the K.P. fails in any of its normal functions, these integrals provide the means of adequately filling the gap. The K.P. is expressible in the form $\Sigma\{e/2V\,.\,(Fu + Gv + Hw - \psi V)\} + d\chi/dt$, where (uvw) is the velocity of an element e of charge, V that of propagation, ψ, F, G, H are potentials, and χ is an integral not evaluated. For two point-charges, the value would be—

$$\{e_2(F_1u_2 + G_1v_2 + H_1w_2 - \psi_1V) + e_1(F_2u_1 + G_2v_1 + H_2w_1 - \psi_2V)\}/2V \equiv L_{21} + L_{12},$$

say, where ψ_1, etc., are values due to the action of e_1, estimated at a place $(x_2y_2z_2)$, where at time t there is a charge e_2 moving with velocity $(u_2v_2w_2)$. Now the force on e_2 due to e_1 has the x-component—

$$e_2\{X_1 + (v_2c_1 - w_2b_1)/V\} = -e_2\left(\frac{1}{V}\frac{\partial F_1}{\partial t} + \frac{\partial \psi_2}{\partial x_2}\right) + \frac{e_2v_2}{V}\left(\frac{\partial G_1}{\partial x_2} - \frac{\partial F_1}{\partial y_2}\right) - \frac{e_2w_2}{V}\left(\frac{\partial F_1}{\partial z_2} - \frac{\partial H_1}{\partial x_2}\right)$$
$$= \frac{L_{21}}{\partial x_2} - \frac{d}{dt}\cdot\frac{\partial L_{21}}{\partial u_2},$$

which is derived, not from the K.P., $L_{21} + L_{12}$, but from $2L_{21}$. This is the first sign of departure from normal conditions. In the statical problem $L_{21} = L_{12}$; in the general problem dynamical equivalence is consistent with inequality if the difference is a complete differential with respect to the time, or, more briefly, if the difference takes the form df/dt, so that there is no immediate certainty of breach of normal conditions. By expanding in powers of V^{-1} the departure is definitely located in the section of terms of odd order, which alone are concerned in radiation. The even groups in L_{12} and L_{21} are shown to have dynamical equivalence and to form an entirely conservative system if treated alone. This section, when acceleration is negligible, admits of a quasi-stationary K.P. without restriction to small velocities. Electromagnetic force is known in respect to odd or even sections, and in the conservative section an expression for the energy follows at once, in the dissipative section only after evaluation of the radiation. The momentum and energy are localised, *i.e.* the parts attached to the two charges distinguished—in the conservative section by use of the K.P.—in the dissipative section by aid of the fluxes at infinity. Two centres being concerned, the treatment of the fluxes is not immediately evident. But the use of information supplied by two methods implies a correspondence to be found which will be a criterion of correct treatment. The agreement of two methods of reduction to a one-time system is involved, and is attained as far as the approximation extends. The scheme of relations so obtained is assumed to have general validity. This involves the possibility of presenting the radiation from two sources in a form free from limitation as to magnitude of velocities; and also of deriving expressions for the terms of odd order in energy, momentum, and force directly from the fluxes at infinity. The integrals are all derivable from one fundamental integral involving the sources symmetrically. The argu-

ment in general deals with joint or product terms in the action of two point-charges. The transition to self-terms, for the dissipative section, offers no difficulty. In the conservative section infinite values would appear if finite though small dimensions were not assigned to the electron. The method employed does not involve any definite structure in the electron, and the author suggests that the determination of this should be left to experimental evidence as to the ratio of two inertias in the case of rapid motion.

G. W. DE T.

1365. *Changes produced in an Electromagnetic Field by the Introduction of a Conducting Sheet.* **M[aria] Binghinotto.** (N. Cimento, 13. pp. 241–264, April–May, 1917.)—Deals with the problem entirely from the mathematical side and arrives at somewhat lengthy expressions for the components of the electric and magnetic forces; for these reference should be made to the original.

L. H. W.

1366. *Energy in the Electromagnetic Field.* **E. A. Biedermann.** (Phil. Mag. 34. pp. 142–146, Aug., 1917.)—A reply to Livens's criticism of an expression given for the magnetic energy density. [See Abs. 319 (1917).]

DISCHARGE AND OSCILLATIONS.

1367. *Effect of Longitudinal Magnetic Field on Glow Discharge.* **R. F. Earhart** and **C. B. Jolliffe.** (Astrophys. J. 46. pp. 76–82, July, 1917.)—Experiments were undertaken for determining the relations between variations of magnetic field and variations of the glow discharge, with the possibility of throwing some light on the conditions governing the phenomena of solar activity and terrestrial magnetic disturbances. In a former paper by one of the present authors [Abs. 1099 (1914)] the results were described for discharges between flat plates with small current density, whereas in the present work the discharge was taken between flat plates and a conical electrode, and extended to larger currents. The results are presented as curves showing relation between current and field strength at various pressures.

C. P. B.

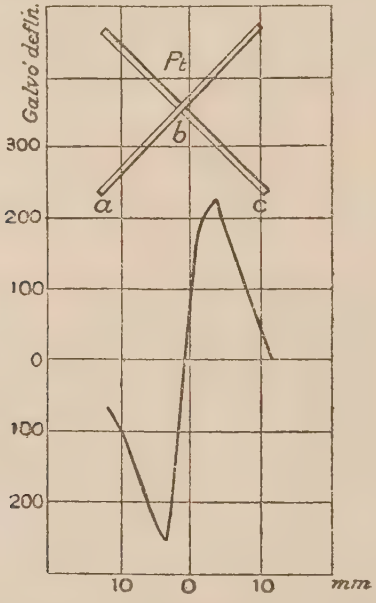
1368. *Characteristics of the Singing Arc under Various Conditions.* **E[lena] Freda** and **N. Mortara.** (Accad. Lincei, Atti, 25. i. pp. 438–445, 1916, and 26. ii. pp. 116–122, 1917. N. Cimento, 13. pp. 297–317, June, 1917.)—An investigation of the voltage-current relation in the main circuit of a singing arc under various conditions as to distance apart of the carbons, and capacity and inductance in the oscillating circuit. The voltage-current curves were obtained by means of the electrostatic deviation of the kathode rays of a Braun tube, and many typical curves are reproduced in the paper.

J. W. T. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1369. *Thermoelectric Effect due to Asymmetric Heating.* **C. Benedicks.** (Comptes Rendus, 165. pp. 391–394, Sept. 17, 1917.)—In a previous paper [Abs. 675 (1917)] the author has described experiments illustrating a new thermoelectric effect produced in a homogeneous metal in which there was an asymmetric distribution of temperature. In these experiments the resistance of the circuit was so small that extremely large currents were produced. In the present paper further experiments are described, the small e.m.f.'s being measured by a sensitive galvanometer. The best effects are obtained

when the temperature gradient is very steep at one point of the circuit. A Pt-wire 0·1 mm. in diam. is carefully annealed and its ends joined to a galvanometer; it is then cut at the middle and the free ends fastened to a rod of porcelain. The Pt-wires lie over one another in the form of a cross. One part of the wire is then heated by a very small flame. A large fall of temperature occurs at the point of crossing of the wires and e.m.f.'s of the order 1 millivolt were obtained. The results, of course, vary with the pressure on the contact. With two Pt-wires 0·25 mm. in diam. welded together at the crossing point, the e.m.f. varies as the source of heat moves



along the path *a b c* (see Fig.). Effects were also obtained with crossed graphite, tungsten, and at the contacts of angular fragments of crystals, such as are used in detectors for wireless telegraphy. L. L.

1370. *Effect of Distributed Capacity in Single-layer Solenoids.* **J. C. Hubbard.** (Phys. Rev. 9. pp. 529–541, June, 1917.)—The author aims at supplementing the work of Drude [Abs. 826 (1903)] each coil forming part of the oscillating circuit of the sort common in radio-telegraphy, one end of the coil being earthed, and not, as in Drude's experiments, oscillating freely as in the Tesla transformer. The author's method of measuring the electrical periods of circuits by means of A. G. Webster's drop chronograph is described [see Abs. 1751 (1915)] and the dimensions and inductances of the wide range of coils examined are given. The results of the research are summarised, the most important conclusions being as follows:—(1) The relation between the square of the period and the external capacity is very accurately linear down to the free period of the coil. This relation is new only in the accuracy with which it has been proved. (2) The distributed capacity of coils earthed at one end is not much affected by the nature of the core. (3) The distributed capacity of such coils is a minimum and practically numerically equal to the radius of coils of length equal to the diam., increasing, for example, by 25 % when the length of coil is 4 times its diam. For

the practical purposes of radio-telegraphy, it is sufficiently accurate to consider the effective capacity of the coil as equal to its radius in cm. of capacity, or to $(r/9) \times 10^{-5}$ mfd. (4) The results extrapolated to the natural periods of the coils, for coils earthed at one end, and with wooden cores, are in good general agreement with the results of Drude for freely oscillating coils *without* cores and of *twice* the axial length. This gives additional support to conclusion (2). (7) It is difficult to reconcile the facts of this paper with the general practice of assuming the effective inductance of an oscillating coil to be $2/\pi$ times the total inductance. This question awaits more precise information as to the distribution of current and potential in a freely oscillating coil. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1371. *Ocean Magnetic Observations*, 1905–1916. **L. A. Bauer** [with **W. J. Peters, J. A. Fleming, J. P. Ault**, and **W. F. G. Swann**]. (Carnegie Inst. of Washington, Publ. No. 175 [438 pp.], 1917 : Vol. 3 of Dept. of Terrestrial Magnetism. Abstract in Terrest. Magn. 22. pp. 129–134, Sept., 1917.)—Contains the final results of the ocean magnetic observations made aboard the *Galilee* in the Pacific Ocean, 1905–8, and aboard the *Carnegie* in the Atlantic, Indian, and Pacific Oceans, 1909–14, together with preliminary results of the observations on the 1915–16 portion of the *Carnegie's* present (fourth) cruise. Special reports relating to auxiliary observations aboard these vessels, and to special—mostly atmospheric-electric—investigations are also included. L. H. W.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1372. *Monocular Method of Stereoscopy Applicable to Radiography.* **J. B. Tauleigne** and **G. Mazo.** (Comptes Rendus, 165. pp. 395–397, Sept. 17, 1917.)—It is found that with an ordinary tube, and consequently by a single emission without any special apparatus of observation, it is possible to obtain a true physical relief that is measurable and can be used in the exact localisation of projectiles in the wounded. It is clear that a single image, absolutely fixed, cannot give in any case a sensation of true relief. But if the object under examination, or the focus of emission of the rays is made to undergo a small angle of displacement in a period ranging from one-quarter sec. to one sec., with an axis of displacement such that at least one of the planes of the subject remains fixed upon the screen, then the other planes undergo a deviation so much the greater as they are removed from this fixed initial plane, and an image is created which has all the elements of stereoscopic vision. It is to be noted, however, that when such an image is viewed with both eyes no sensation of relief appears. It is also found that the apparent relief may be either direct or reversed. It is sufficient to shut and reopen the observing eye to obtain successively these two aspects of relief. Several observers viewing the same image at one time may thus obtain different views of its relief. It is expected that this procedure will be of great service in the radioscopic localisation of projectiles, and still more in extractions under the screen. A. E. G.

1373. *Physical Properties of Intensifying Screens.* **T. T. Baker.** (Röntgen Soc., J. 13. pp. 49–56 ; Disc., 56–58, July, 1917.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1374. *Adsorption of Carbon Dioxide and Ammonia by Charcoal.* **L. B. Richardson.** (Am. Chem. Soc., J. 39. pp. 1828–1848, Sept., 1917.)—Previous measurements of the adsorption of gases by charcoal [see Titoff, Abs. 549 (1911)] have not been carried out at pressures greater than 1 atmo. In the present investigation the equilibrium pressures of the system, carbon dioxide —coconut charcoal, have been measured at pressures from 0–300 cm., and at 21 different temperatures between —64° and 200°. The same pressure-range has been used for the system ammonia—coconut charcoal, the temperatures, however, varying between —20° and 200°. Through a limited pressure-range the degree of adsorption of the gas is in fair agreement with the logarithmic isotherm equation of Freundlich, but at pressures above 60 cm. the adsorption rapidly decreases, indicating that at each temperature a maximum is reached which cannot be increased by increase of pressure. There was no evidence of the formation of a chemical compound, such as that obtained by Rhead and Wheeler in the adsorption of oxygen by charcoal, by the reverse action of CO_2 upon charcoal at relatively high pressures.

At low temperatures gas which has just been brought into contact with the charcoal fails to reach equilibrium in a reasonable time; also, at these low temperatures, the equilibrium pressure at a given point obtained on a falling temperature is slightly different from that obtained at the same point on a rising temperature. This behaviour is possibly due to a small quantity of gas being absorbed in the charcoal structure, in accordance with the theory of McBain. T. S. P.

1375. *Ultramicroscopic Investigation of very Thin Metal and Salt Films obtained by Evaporation in High Vacuum.* **W. Reinders** and **L. Hamburger.** (K. Akad. Amsterdam, Proc. 19. pp. 958–968, 1917.)—When a tungsten filament, which has been partially covered with solid sodium chloride, is heated in a high vacuum (0·0003–0·0010 mm.) in a glow-lamp, a clear, colourless deposit settles on the glass of the lamp [see Abs. 239 (1910)]. Ultramicroscopic investigation shows that this deposit is optically homogeneous; it must be considered to consist of the salt in the amorphous-vitreous state. When the deposit is submitted to the action of moist air it becomes opalescent, owing to the formation of separate crystals whose growth can be followed ultramicroscopically. When a silver filament is heated in the high vacuum of a glow-lamp, a deposit forms on the walls of the bulb; with increasing thickness the colour of this deposit passes from greenish-yellow through orange, red, and violet to blue. The red, violet, and blue films are distinctly heterogeneous, consisting of a network of very small ultramicrons. The heterogeneous character of the yellow deposit is hardly perceptible, the structure approximating to that of the amorphous-vitreous state. The deposits are not stable in the presence of moist air; the colour changes in the direction yellow ⟶ red ⟶ blue, and the structure becomes coarser. Heating likewise brings about a coarsening of the structure. Gold filaments give coloured deposits which are ultramicroscopically heterogeneous. Tungsten gives a black deposit which cannot be optically resolved in the ultramicroscope. Deposits obtained by kathodic disintegration are coarser-grained than those produced by evaporation in high vacua. T. S. P.

1376. *The Extinction of Para-azoxyanisol in the Magnetic Field. I. Liquid Crystals.* **W. J. H. Moll** and **L. S. Ornstein.** (K. Akad. Amsterdam, Proc. 19. pp. 1315–1321, 1917.)—Voigt has devoted a circumstantial report to the subject of liquid crystals [Phys. Zeits. 17. p. 76 *et seq.* 1916], in which he points specially to the fact that a great uncertainty still exists regarding the influence exercised by a magnetic field on the extinction. For this reason the present authors have further examined the extinction. The method of observation is first explained in detail; the extinction being measured with the aid of the galvanometer and thermopile previously described [Abs. 747 (1914)]. These sensitive instruments have the great advantage of indicating quickly within 2 secs., and so enabling the changes to be followed in the liquid crystal, which, although proceeding slowly, are so rapid as to escape an observer's attention. These changes are of great interest for understanding the phenomena under consideration. The various measurements and conditions prevailing then follow, accompanied by diagrams. It appeared that the changes in the extinction caused by the magnetic field often persisted, so it became advisable to reduce the matter to its original state before the beginning of every series of measurings, this being effected by heating it up to a little above the second point of transition. The difference between the two phenomena is very characteristic; whereas the perpendicular field excited for the first time a temporary increase of the extinction, nothing of the sort is observed when the horizontal field is excited. Whereas after the breaking up of the perpendicular field the extinction is much larger than in the virginal state, the extinction is much smaller than before after the removal of the horizontal field. This condition of diminished extinction seems to be stable, since it holds during some hours: the condition of increased extinction, as left after the removal of the perpendicular field, is of a transitory nature, the virginal state being gradually restored. The authors have not been able to establish whether commutation of the magnetic field has any influence on the extinction, and this appears to indicate that the particles themselves possess no polar peculiarities. An explanation of the observed phenomena is drawn in outline whereby the principal supposition is that the wall of glass directs the particles into parallel planes and, accordingly, influences the lines of force. H. H. Ho.

1377. *Reduction of Highly-reactive Metals and Metalloids (Ti, Zr, B).* **E. Podszus.** (Zeits. Anorg. Chem. 99. pp. 123–131, May 25, 1917. Engineering, 104. pp. 259–260, Sept. 7, 1917. Abstract.)—Very fine subdivision of the material is obtained in a steel bomb which acts both as grinding mill and reaction chamber. The bomb is charged with a mixture of titanium chloride or potassium zirconium fluoride and pieces of metallic sodium; several hard steel balls, 2 cm. in diam. are added, and the bomb is sealed with the aid of fused lead and kept revolving for 40 hours at 200° C. The temperature is then raised to start the reaction, which is completed in a few minutes. The bomb is afterwards cooled from the top downward, and the lead removed. In this way a titanium powder was obtained which melted to a silvery, slightly yellowish metal of 99·7 %; the zirconium was 99·3 % pure. Very little is said about the products, but the difficulties experienced in the isolation of boron, and the apparatus used for this purpose, are fully described. By the process mentioned boron could only be obtained as a black powder which reacted with the gases in the bomb (hydrogen, nitrogen, CO, and CO_2). Electro-thermic reduction of boron chloride with pure iron wire proved no more successful. The oxide B_2O_3 is first converted into the white, refractory

nitride BN by being heated in an atmosphere of nitrogen or ammonia; the nitride (and also boron carbide) is the material for the frame on which the iron wire is wound and for the furnace tube; the furnace consists of an iron cup and an iron tube, and in this furnace BCl_3 is reduced. The furnace is first charged with hydrogen, which is then expelled by BCl_3. The reduction begins at 800°, but iron boride being also formed, the temperature must be raised to 1700°. The resulting boron volatilised completely when heated in hydrogen; in the blowpipe it was burned to nitride and some oxide. Boron wire, free from iron, did not melt even when an electric arc played between two pieces of wire; but it was brittle, and impurities greatly affected its properties. H. B.

1378. *Zirconia and Zirconia Apparatus.* **E. Podszus.** (Zeits. Angew. Chemie, pp. 17–19, 1917. Engineering, 104. pp. 500–501, Nov. 9, 1917. Abstract.)—The cracking of objects made from zirconia can be prevented by first fusing the zirconia, grinding it very fine (as explained in preceding Abs.), making a paste of the powder and water, to which some organic binding agent is added if compression be undesirable, and moulding the objects, which are then burnt at 2300° C. or higher temperature; when these high temperatures are not available, phosphoric or boric acid may be added to the paste; these acids would be expelled again at 2100°. The melting of the zirconia is effected as follows: An electric arc is established between vertical carbon electrodes, first in contact, embedded in the powdered zirconia. A little carbide is formed which melts and covers the lower electrode; thus a small cavity is produced. The electrodes are then pulled apart, and the zirconia melts on the walls of the cavity; with an arc of 50 to 100 amps. at 220 volts, several kg. of zirconia are melted in half an hour. Thoria is melted in a similar way. The burning of the objects is effected in a gas- or oil-furnace with zirconia walls by a blast of air or oxygen giving up to 3000°; the apparatus are not illustrated. Pure zirconia is almost white, but mostly yellowish with traces of iron; it melts at 2950° or 3000°, and is not reduced by hydrogen at 2200°; wound with tungsten wire a zirconia rod does not seem to volatilise at the highest temperatures. Whether prolonged heating of the zirconia yields a black suboxide (Ruff) is uncertain. H. B.

1379. *Classification of Nickel and Manganese Steels.* **P. Dejean.** (Comptes Rendus, 165. pp. 334–337, Sept. 3, 1917.)—Two groups of Ni-steels are generally distinguished: (1) Steels with less than 25 % Ni called irreversible, the temperatures of the critical points on cooling and on heating being different; (2) reversible steels with more than 25 % Ni, the critical points of which are substantially at the same temperature on cooling and heating. The authors show that group (1) should be subdivided. Between 0 and 10 % Ni the steels are pearlitic, pseudo- or quasi-reversible; between 10 and 25 % Ni they are martensitic and irreversible; beyond 25 % Ni they become austenitic. In the case of Mn-steels similar groups may be distinguished, but they overlap. The carbon percentage is important. Steels with less than 0·4 % C and from 0 to 3·5 % Mn are pearlitic and show point A; with 3·5 to 11 % Mn they are martensitic and show point B; the intermediate range 3·5 to 4 % Mn gives both A and B, consisting of both martensite and troostite. When the carbon rises to 0·7 and 1%, the intermediate range predominates, the temperature of A being raised, whilst that of B is lowered; by suitable cooling the point A can be produced in steels which have their B below 0° C.; these steels consist of troostite and austenite. A diagram of these Mn-steels, plotting Mn against C, is added to the curves. H. B.

1380. *Tchernoff's Point b.* **D. K. Tchernoff.** (Rev. de Mét. 14. pp. 126–136, March–April, 1917. Translation of letter to Russian Metallurg. Soc. J.)—In 1868 Tchernoff presented a memoir to the Imperial Russian Technical Society in which he enumerated the existence, during heating, of three critical points in steel, and characterised as follows: Point *a* by the appearance of hardening, point *b* by the transformation of a coarsely crystalline into a fine structure, and point *x* by the appearance of crumbling of the overheated steel, in which state hammering shattered the material.

The present letter is a reply to various criticisms of these conclusions, and the writer first points out various mistaken notions with regard to his points, *a*, *b*, and *x*. At the time of his work the only method of measuring temperatures was by means of the eye; *b* was described as occurring at a "white heat" and unfortunately reported as 1300° C. on Pouillet's scale, an estimate which subsequently proved to be far too high. If, when 20 years later Osmond determined the critical points by means of a pyrometer, we had only corrected Tchernoff's estimate of the temperature, all confusion would have been avoided. Point *b* really corresponds to Osmond's point A3, and Tchernoff imagines that on attaining this temperature during heating, the crystalline arrangement of the molecules become amorphous, thus permitting of a recrystallisation on the reversal of the thermal process. In the letter it is pointed out that there is still a tendency to confuse physical and chemical equilibria. Further, it is not necessary to resort to the allotropic theory to explain the magnetic transformation at A2. The original diagram of Tchernoff is reproduced and compared with the modern equilibrium diagram of the Fe–C series. F. C. A. H. L.

1381. *Effect of Strain on Heterogeneous Equilibrium.* **E. D. Williamson.** (Phys. Rev. 10. pp. 275–283, Sept., 1917.)—The author deduces equations connecting the changes of the variables which determine the equilibrium between a stressed solid and a liquid phase. These equations are grouped in two classes, A and B, referring to a free surface and to a thrust surface respectively. The formulæ are extended to solutions. The author points out that while in the case of group A the assumptions made seem justifiable, the assumptions usually made in the case of group B are doubtful, and experimental evidence is necessary, and is being sought for. A. F.

1382. *Influence of Temperature on Chemical Equilibria.* **F. E. C. Scheffer.** (K. Akad. Amsterdam, Proc. 19. 4. pp. 636–649, 1917.)—Section I of the paper deals with the expression for the influence of temperature on equilibria.

When in a rarefied gas mixture or a diluted solution a chemical reaction is possible, there exists a definite relation between the concentrations of the reacting substances in the state of equilibrium. The equilibrium constant is such at a definite temperature, but varies at changing temperature. Van't Hoff's expression $d \log K/dT = -E/RT^2$ evaluates this variation and must be integrated for definite cases, for which purpose E must be known as a function of the temperature. If, however, E be regarded as a constant, *i.e.* if the change of energy in the reaction is independent of the temperature, and, therefore, the sum of the specific heats of the substances of the first member of the reaction equation equal to that of the second, then by integration $\log K = +a/T + b$, where *a* and *b* are constants. This, however, is certainly not the case in general, although the influence of the specific heats is so small for almost all equilibria that the mistake made by its neglect is smaller than observational error. Hence the above equation meets with general application owing to its simplicity. The author also prefers this equation for other

reasons than its simplicity. In chemical literature many equilibria are described by means of more complicated expressions; now there are two cases possible: either the observations can just as well be represented by the formula with two-constant quantities or they cannot. In the latter case very great observational errors must be present, and the great advantage of the simple equation is that attention is thereby drawn to these errors. The author gives a number of examples, *e.g.* the carbonic acid dissociation, to show that the simple equation is just as suitable as the more complicated, and also applicable to some examples not so represented, and in the author's opinion desirable of repetition for the purpose of correcting inaccuracies, *e.g.* the hydrogen iodide dissociation. Of the gas reactions, the author knows of no example for which the two-constant formula expresses the observations less accurately than more complicated formulæ, since the influence of the specific heats is always small and exceeded by the errors of observation.

A greater influence of the specific heats may be expected for the gas reactions in which also solid substances take part, for then not only the different way of binding of the atoms, but also the difference in state of aggregation plays a part. In the literature there are described a number of equilibria, which would show a maximum or a minimum value for K at a definite temperature. It is clear that if this is true, the two-constant formula cannot be applicable; since this excludes the appearance of maxima and minima. The author has examined these examples and arrived at the conclusion that a maximum or minimum occurs in none of these reactions, and the particularities found are exclusively the result of errors in the observations. The cases considered in the paper are: the equilibria between the iron oxides, the dissociation of ammonium bromide, and the water-gas equilibrium. The latter has been quoted as an example of a reaction with a max. value of K, a conclusion which, however, is not derived from direct observation, but rests on great extrapolation of data which themselves are partially inaccurate. The author points out that at the temperature where the equilibrium shows a reversal of sign, the reacting substances themselves would be subjected to new decompositions and the realisation of the phenomena would be excluded. He concludes by stating that a transition case might be found for a reaction having a very small heat of conversion over a very great range of temperature, although an example of this is at present unknown. H. H. Ho.

1383. *Two Laws Governing the Ionisation of Strong Electrolytes in Dilute Solutions and a new Rule for determining Equivalent Conductance at Infinite Dilution.* **E. W. Washburn.** (Nat. Acad. Sci., Proc. 3. pp. 569–577, Sept. 15, 1917.)—From the conductivity data which the author has obtained, he states the two laws: (1) In sufficiently dilute solution (*i.e.* for all practical purposes below 0·0001 normal) all uni-univalent salts of strong acids and bases obey the mass-action law, and all of them have the same ionisation constant. (2) In sufficiently dilute solutions the values of the mass-action expression for all such salts are identical, the identity persisting up to higher concentrations the more nearly the salts under comparison resemble each other, and in any case persisting within the experimental error up to 0·0002 normal for all salts which have been accurately measured at these concentrations. In the case of two salts, such as potassium chloride and potassium bromide, for example, which resemble each other very closely, this identity persists up as high as 0·005 normal. With the aid of this second law

it is possible to derive a general rule by means of which the Δ_0 value for any uni-univalent salt can be accurately obtained from the value of the equivalent conductance of that salt at a single concentration, say 0·0001 normal. The rule is deduced as follows: The second law stated above may be expressed mathematically by the equation $\Lambda^2C/[\Lambda_0(\Lambda_0 - \Lambda)] = K_E$, where the value for K_E is independent of the nature of the salt, and can therefore be read off from a curve obtained by plotting the values of K_E, the mass-action expression, against values of the concentration. Solving this expression we obtain with sufficient accuracy, $\Lambda_0 = \Lambda_c(1 + c/K_E)$, an expression by means of which the value of Λ_0 for any salt can be calculated from a single value of Λ_c for that salt.

The reason why strong acids and bases themselves, as well as salts of weak acids and bases, are not included in the scope of the laws as formulated above, is not because there is any reason to suppose that these substances form exceptions to the laws but merely because there are no reliable data available for testing the laws in any of these cases, nor can such data be secured except by employing extremely pure water. The author gives a table illustrating the validity of the above laws. A. F.

1384. *The Relative Electrode Potentials of Tin and Lead determined by Equilibrium Measurements with their Perchlorates.* **A. A. Noyes** and **K. Toabe.** (Am. Chem. Soc., J. 39. pp. 1537–1545, Aug., 1917.)—Determinations of the equilibrium between metallic lead and tin and tin and lead perchlorate in dilute perchloric acid solution at 25° have been made. These determinations have given the value 2·98 for the equilibrium ratio of the tin and lead concentrations in this solution, while Sackur found for this ratio the value 3·34 to 3·45 in dilute solutions of the two chlorides. Assuming that the value 2·98 represents also the ratio Sn^{++}/Pb^{++} of the concentrations of the tin ion and lead ion in the perchlorate solution, the specific electrode potential of tin is computed to be 0·0140 volt larger than that of lead. From e.m.f. data existing in the literature the specific electrode potential of lead referred to the molal hydrogen electrode, has been re-computed and found to be + 0·132 volt. That of tin then becomes + 0·146 volt. These values are probably accurate within ± 0·002 volt, so far as they are influenced only by experimental errors. A. F.

1385. *Accurate Determination of Silver by Electrolytic Deposition from Cyanide Solutions.* **A. S. McDaniel** and **L. Schneider.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 19. pp. 7–13, 1915–1916.)—A deficiency in the weight of silver deposited during rapid electrolytic analysis is obtained through loss of metal during the washing of the deposit by the solvent action of the cyanide electrolyte, and through the depolarising action of certain reducible substances in the electrolyte which lead to the discharging of hydrogen at the kathode before the last traces of silver are separated. Measurements made by the compensation method of the single p.d. between kathode and electrolyte showed considerable divergencies with a cyanide electrolyte in presence of different salts. With a current density of 0·5 amp./dm.² hydrogen gas begins to evolve after a lapse of from 5 to 10 mins., and the potential against the normal calomel electrode rises to a max. constant value approximating 1·43 volts with iodide and nitrate solutions except where excess of sodium nitrate is present, when this constant value is 1·35 volts. With silver iodide together with potassium iodide and iodine, the constant potential is about 0·78 volt. When silver cyanide is used the potential lies higher than in any

other case until the visible evolution of hydrogen begins. The results shown by the curves indicate that a small, invisible amount of hydrogen is deposited along with the silver and that the anodically oxidised halides and nitrates function as hydrogen depolarisers reducing the potential of the hydrogen towards the electrolyte. This depolarisation, which is intensified by the presence of hydrogen peroxide or iodine, was seen to lead to the re-dissolving of previously deposited silver even when using current densities of from 2 to 3 amps. The depolarising action of nitrates is apparently limited in speed relative to the current density since at higher densities, such as are used in the rapid determination, the deficits produced by the depolarising action of iodine from iodides are greater than those produced by nitrates, whereas the reverse is the case at lower current-densities. Positive errors arise in the electrolytic cyanide method by the presence of colloids, in particular brown colloidal paracyanogen which is formed at the anode, resulting in spongy deposits and occlusion of the electrolyte. The formation of this colloid is entirely prevented by the use of high temperatures and vigorous stirring. A further source of positive errors when low current-densities and low temperatures are used is the blistering of the deposits which causes the occlusion of large amounts of electrolyte. For accurate rapid determinations the stirring with the anode should not be less than 300, though on account of the danger of spattering, not above 500 revs. per min. The temperature of the electrolyte should not be less than 80° C., the current density from 2 to 4 amps./dm.^{2}, and the duration of the electrolysis from 15 to 20 mins. for the deposition of one or two gm. of silver. The deposit is washed during an interval not exceeding one minute by first raising the current density to 6 or 8 amps., then pouring water from a beaker directly into the electrolysing dish and allowing it to overflow into a large funnel clamped beneath the dish until the ammeter shows no further current. The washed deposit is dried at 160° C. for half an hour, ignited for a few seconds to dull redness in a darkened room to ensure complete removal of organic matter and moisture, and weighed. The addition of potassium iodide equivalent in amount to the silver present will entirely prevent the formation of colloidal paracyanogen and give a deposit free from inclusions, but, in this case, a current density of at least 4 amps. must be used. J. N. P.